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RCAP

Mr. William F. Lowe
U.S. Environmental Protection Agency
901 North 5th Street
Kansas City, KS 66101

Subject: RFI Report
Van Waters & Rogers Inc., Buckingham Place Facility
Omaha, Nebraska

EPA ID # NED986375327

Dear Mr. Lowe:

Van Waters & Rogers (VW&R) has received comments, dated October 1, 1999, from the U.S. Environmental Protection Agency (U.S.EPA) on the draft RFI Report for the referenced facility. VW&R proposes the following revisions to the report to address the comments so that the U.S.EPA can approve the RFI as a final report. The proposed revisions are submitted for review and, if necessary, discussion. Subsequently the report will be revised accordingly and submitted to the U.S.EPA as the final RFI Report.

Each proposed revision is numbered using the U.S.EPA's numbering from the comment letter. To clearly highlight the proposed revisions, added text is marked by underlining and deleted text is marked by strikeout.

1. The EPA identification number for the facility will be added to the cover page of the report.
2. On Page 7, Section 3.3, Paragraph 1, the first sentence will be revised as follows:

Several areas of stained soil and several containment systems that exhibited evidence of a lack of integrity were observed during the RFA conducted in August 1989 (PRC Environmental Management, Inc., 1992).
3. On Page 7, Section 3.3, Paragraph 2, the first sentence will be revised as follows:

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The samples were tested for the presence of ~~COPCs~~ VOCs, SVOCs, pesticides, PCBs, and metals.

In addition, text will be added to the end of paragraph 2 as follows:

The results of the Phase I Investigation were used to plan the RFI and to supplement data collected during the RFI. Because the Phase I data are used to address objectives of the investigation, the data are presented in this report alongside RFI data for completeness and clarity. The Phase I data meet the data quality objectives presented in the quality assurance project plan for the RFI (Geomatrix, 1997a).

4. An acronym list will be added to the report. The acronym "TCL" is defined on Page 7, Section 3.3, Paragraph 2, Sentence 2 as "Target Compound List".
5. Table 2 will be revised to indicate the dates when the various soil borings were drilled to make it easier to understand the different phases of the RFI.
6. This comment is addressed with Comment 7.
7. Page 10, Section 5.1.1, Paragraph 2, Sentence 3 will be revised as follows:

The second phase ~~if~~ of drilling was conducted pursuant to the U.S.EPA-approved work plan in April-June 1997...

8. Page 12, Section 5.2 will be revised to clarify the use of the terms "COPC" and "COC", as follows:

Soil and groundwater samples were collected at numerous locations and tested for the presence and concentration of the COPCs listed in Table 1. A COPC is a chemical that has the potential, based on the available information, to be detected at concentrations that may require corrective action. The concentration and location of COPCs was a primary subject of the investigation. As the investigation progressed and chemical tests results became available, some groups of chemicals were no longer considered COPCs or chemical test parameters because their concentrations were below generic risk-based criteria. For example, when SVOCs were not detected above generic risk-based criteria in the first phase of the investigation, SVOCs were not retained as COPCs during subsequent phases, such as off-site soil sampling. However, because VOCs were detected above generic risk-based concentrations in shallow soil, VOCs were retained as COPCs during testing of deep soil samples and during testing of soil

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samples collected off-site. The same approach was followed during groundwater chemical testing.

The chemical test results for COPCs were further evaluated during the risk characterization by comparison to site-specific risk-based criteria to arrive at a list of COCs that require corrective action.

With the text revised to clarify the distinction between COPCs and COCs, the reference to Table 1 in Section 5.2 seems to be appropriate. The table that lists the COCs (Table 21) is not referenced in Section 5.2 because the list of chemical parameters for which samples were tested during the investigation included many more constituents than those listed in Table 21.

9. A future construction/utility worker scenario was evaluated to compare the risk for future construction/utility workers to that for future industrial workers. This evaluation was qualitative in nature based on the results of the quantitative evaluation for the industrial worker. The results of the qualitative evaluation show that the risk to future construction/utility workers would be less than or equal to that calculated for the industrial worker. Therefore, the intermediate screening criteria calculated for the industrial worker scenario are protective of a construction/utility worker. Page 14 (Section 5.3) and Page 46 (Section 8.1.2) will be revised as follows:

5.3 RISK CHARACTERIZATION

The chemical test results for soil were used to characterize the potential risk posed to human health. First, the test results were compared to human health risk-based criteria to identify which of the initial list of COPCs are present in soil at concentrations that might pose an unacceptable risk to human health. A comparison of Facility data to the risk-based criteria was enough to conclude that some corrective action will be necessary for soil; therefore, no baseline risk assessment was conducted. Second, intermediate screening criteria (ISC) were developed for the COPCs in soil that exceeded the risk-based criteria. ISCs are estimated concentrations of constituents in the soil that are protective of human health over a lifetime of exposure. ~~The future use of the site is expected to be industrial, and therefore the ISCs were based on an adult industrial worker scenario.~~ The future use of the Facility is expected to be industrial. For future industrial use, the Facility would need to be redeveloped entailing short-term construction and utility work. The assumptions and default values used to calculate ISCs for a long-term industrial worker were compared to those for a short-term on-site construction/utility scenario. This comparison is discussed in Section

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8.1.6 and shows that the ISCs for an adult industrial worker are protective of a construction/utility worker. Therefore, the ISCs were based on an adult industrial worker scenario.

8.1.2 Potential Receptors and Exposure Routes

Based on current and planned future industrial use of the Facility, potential receptors are limited to future long-term on-site industrial workers and short-term on-site construction/utility workers. The area of concern is not used currently; there are no on-site workers. The fence surrounding the Facility prevents others from accessing the Facility. The planned use for the Facility is industrial.

Section 8.1.6 will be added the report, as follows.

8.1.6 Qualitative Evaluation of Future Construction/Utility Worker Scenario

A future construction/utility worker scenario was qualitatively evaluated based on the quantitative results of the adult industrial worker scenario. Assuming corrective measures addressed the areas illustrated in Figure 20, the residual cancer risk for a future industrial worker would be 1×10^{-5} and the residual noncancer hazard index would be 0.3. The exposure factors (e.g., exposure frequency) assumed for the industrial worker are different from those that are generally assumed for a construction/utility worker. The exposure factors that are the most different include the following:

- Exposure duration for a future industrial worker is assumed to be 25 years, while a construction/utility worker is generally expected to be present at a construction site for 1 year or less
- Soil ingestion rate for a future industrial worker is assumed to be 50 milligrams per day (mg/day), while the ingestion rate for a construction/utility worker is assumed to be 480 mg/day
- The particulate emission factor (PEF) for a future industrial worker is assumed to be 1.316×10^9 cubic meters per kilogram (m^3/kg), while the PEF for the construction/utility worker is assumed to be $1 \times 10^6 \text{ m}^3/\text{kg}$.

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In addition, because the construction/utility worker has a short-term exposure duration (i.e., 1 year), it is more appropriate to use a sub-chronic reference dose (RfD) to evaluate noncarcinogenic health effects rather than the chronic RfD used for the industrial worker; sub-chronic RfDs are generally a factor of 10 higher than chronic RfDs. Based on these factors, the noncarcinogenic risk to a construction/utility worker is approximately the same as that calculated for the industrial worker (based on an increased soil ingestion rate and PEF and increased RfD). The carcinogenic health risk to a construction/utility worker is approximately a factor of 10 lower than that calculated for the industrial worker (based on lower exposure duration, and increased soil ingestion rate and PEF). Therefore, the risk to future construction/utility workers would be less than or equal to those calculated for the industrial worker.

10. The words "direct-push sampler" will be used instead of Geoprobe[®], throughout the document.
11. Page 18, Section 6.2.2, Paragraph 1, last sentence, will be revised as follows:

Continuous core samples were collected at PZ1, PZ2, and PZ3 from the ground surface to the bottom of the boreholes (107, 48.5, and 72 feet bgs, respectively) to evaluate stratigraphy in the Spring Lake Park Area.
12. The location of the chemical data will be provided in Section 6.4 and 6.6 by adding the following sentence to the end of Page 20, Section 6.4, Paragraph 1 and Page 27, Section 6.6, Paragraph 2:

The chemical analytical data are presented and discussed in Section 7.2.
13. Page 22, Section 6.4.4, last sentence, will be revised as follows:

Table 7 summarizes the hydrologic tests conducted during the investigation. ~~ing program.~~ Test results are presented and discussed in Section 7.1.

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14. For purposes of this evaluation, cumulative target risk-levels of 1×10^{-5} and hazard index of 1 were used for carcinogenic and noncarcinogenic chemicals, respectively. To explain that the approach is also protective when viewed as risk levels for individual constituents, Page 29, Section 6.9.1.2 and Page 48, Section 8.1.4 will be revised as follows.

6.9.1.2 Identification of Areas Potentially Requiring Corrective Action

The comparison of Facility data to the risk-based criteria was sufficient to conclude that some corrective action will be necessary for soil. Therefore, no baseline risk assessment was conducted. Instead, the areas of soil that may pose an unacceptable risk to potential receptors were identified by the following process: 1) identifying potential receptors and exposure pathways, 2) estimating exposure point concentrations based on current conditions, 3) identifying geographic areas that contribute most significantly to the overall risk, and 4) estimating the residual risk (i.e., the risk that would remain) after areas of concern were hypothetically contained, removed, or otherwise addressed by corrective action. These steps were repeated in an iterative fashion. The area potentially requiring corrective action was increased in size until the residual risk was reduced to a level equal to or below 1×10^{-5} for carcinogenic chemicals (i.e., as an aggregate; risks for individual constituents did not exceed 3×10^{-6}) and a hazard index of 1 for non-carcinogenic chemicals. Default input parameters prescribed by U.S.EPA for the potential receptors, accounting for potential exposure pathways, were used to identify areas that may require corrective action. Potential receptors were identified as future long-term industrial workers and future short-term construction/utility workers.

8.1.4 Areas of Concern

Areas of the Facility that contribute most significantly to the overall risk were identified by comparing the representative concentration for each of the COPCs to an intermediate screening criterion (ISC) for soil. These intermediate criteria were calculated following the methodology provided in U.S. EPA, Region 9 Preliminary Remediation Goals (PRGs) (U.S. EPA, 1998c). The methodology prescribed in this document is preferred to that prescribed by Region 3 because it incorporates exposure through all of the identified exposure pathways including ingestion, dermal contact, and inhalation of particulates or vapors while the methodology provided by Region 3 incorporates only the ingestion of soil pathway. U.S. EPA, Region 9 PRGs combine current EPA toxicity values with standard exposure factors to estimate concentrations in environmental media (in this case, soil) that are protective of human health, including sensitive subgroups, over a lifetime. For purposes of this evaluation, default

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input parameters prescribed by U.S. EPA for an adult industrial worker were used. Noncarcinogenic and carcinogenic toxicity criteria were based on values provided in the U.S. EPA Integrated Risk Information System (IRIS) database (U. S. EPA, 1999). Target risk levels of 1×10^{-5} (as an aggregate target risk level for all chemicals; risks for individual chemicals did not exceed 3×10^{-6}) and hazard index of 1 were used for carcinogenic and noncarcinogenic chemicals, respectively. The calculations and input parameters are presented in Appendix E.

15. On Page 33, Section 7.1.2, the reference in the final paragraph will be changed to Figure 8.
16. Page 36, Section 7.2.1, Paragraph 3 will be revised as follows:

Metals were frequently detected in soil at the Facility. The detected concentrations are summarized in Table 19 including the range of values and the mean for each metal. Information in Table 19 is used to compare data from the Facility to data from the adjacent VW&R facility (Geomatrix, 1998b) and to native soil from a study by the U.S.GS (Shacklette and Boerngen, 1984). The range of values for metals throughout the Facility suggest typical variation within soil and do not indicate the presence of "hot spots" of large metal concentrations, with the exception of lead and iron. The results for lead and iron in Table 5 show the outlier is the surface sample at BP-5. Metals results for the Facility are comparable to those from the adjacent VW&R facility (Geomatrix, 1998b). When compared to published native soil concentrations (Shacklette and Boerngen, 1984), just one metal result exceeded the range observed under natural conditions. This result was for lead, at 829 mg/kg in the surface soil sample collected at BP-5. All other lead results were within the range of native soil concentrations. The result for iron at BP-5 is within the range for native soils.

Table 19 is a new table, and is attached. Tables from the draft report will be renumbered and references to these tables in the text of the report and the table of contents will be changed accordingly.

17. All references to "U.S. EPA, 1998" in the text will be revised accordingly to reflect the following changes to Section 10.0 References:

U.S.EPA, 1998a. U.S.EPA Region III Risk-based concentration table, October 1998.

U.S.EPA, 1998c. U.S.EPA Region IX. Preliminary Remediation Goals (PRGs), 1998.

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18. The reference will be changed to "U.S.EPA, 1999~~b~~" on Page 48, Section 8.1.4, Paragraph 1.
19. The term COC will be used instead of COPC on Page 48, Section 8.1.4, Paragraph 2.
20. Text concerning the evaluation of the fate and transport of COCs in groundwater is expanded throughout the report to provide additional information regarding this subject. Data regarding the fate and transport of COCs and the results of natural attenuation screening are transferred out of the text and onto two new tables to be more concise. The two new tables are attached. The table numbering within the report will be revised as needed. This revision also addresses comment 22.

Page 26, Section 6.6, Paragraph 1 is revised as follows:

6.6 GROUNDWATER SAMPLE ANALYSIS

Chemical analysis of groundwater samples ~~were was~~ conducted for COPCs and natural attenuation parameters (U.S.EPA, 1997b) by CAS at their laboratory in Kelso, Washington. Midwest Laboratories, Inc. (Midwest) of Omaha, Nebraska analyzed the groundwater screening samples collected from off-site borings BSS51 and BSS52.

Page 29, Section 6.9.2 is revised as follows:

Environmental Database Resources, Inc. was used to conduct a search for water wells within the Facility area. This information supplemented the data in the DCC (Geraghty & Miller, 1996). The City of Omaha was contacted to obtain information regarding ordinances covering groundwater development in the area.

Hydrostratigraphic and topographic data were used to evaluate groundwater migration pathways. Physical and geochemical data were used to evaluate the fate and transport of COCs. The calculation of groundwater fate and transport parameters is presented in Table 14.-

Page 39, Section 7.2.2.2 is revised as follows:

7.2.2.2 Attenuation Parameters

The pattern of geochemical conditions and the large decrease in COC concentrations observed along the groundwater flow path downgradient of the source area provide strong evidence of natural attenuation based on the applicable U.S.EPA technical

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protocol (U.S.EPA, 1998b). Anaerobic conditions are established in the source area, and where anaerobic conditions exist there is strong evidence in the geochemical data for reductive dechlorination. The natural attenuation screening protocol using Facility data is summarized in Table 21. Under these geochemical conditions, TCE will be reductively dechlorinated in a sequence to DCE, vinyl chloride, ethene and carbon dioxide. Farther downgradient, where aerobic conditions are re-established, DCE and vinyl chloride will degrade to ethene and carbon dioxide.

The attenuation ~~parameters~~ parameter concentrations, presented in Table 4922, indicate that anaerobic conditions are present at some locations, such as the source area, within an overall aerobic environment. The presence of anaerobic conditions is indicated by low (i.e., below one milligram per liter) dissolved oxygen, and relatively high methane, relatively high dissolved iron, and relatively low nitrate concentrations. The presence of an overall aerobic environment is suggested by relatively high dissolved oxygen, relatively low dissolved iron, and relatively high nitrate concentrations at downgradient locations.

(Note: Table 21 is a concise presentation of the following text, which is therefore proposed for deletion.)

~~Dissolved oxygen concentrations were observed to be generally less than one milligram per liter at the Facility, with higher concentrations downgradient of the Facility at MW7I and MW8I. Methane was detected at up to 43 g/l at MW3I, at up to 13 g/l at MW5I, and over 1 g/l at MW4S, and MW7I. The consumption of oxygen and production of methane is indicative of bioactivity. Ethane and ethene were detected at relatively high concentrations at MW3I, suggesting anaerobic dechlorination of chlorinated ethenes, such as PCE, TCE and DCE. The prevalence of "daughter products" of PCE, TCE, and 1,1,1 TCA are indicative of reductive dechlorination, which occurs most readily under anaerobic conditions. Dissolved iron concentrations above one milligram per liter were detected at MW4S, MW2I, MW4I, MW5I, and MW6I. The presence of dissolved iron is indicative of reducing conditions. Nitrate was detected at relatively low concentrations at MW1I, MW3I and MW5I compared to relatively high concentrations at MW2I, MW4I, and MW8I. A decline in nitrate concentrations relative to background conditions is indicative of the presence of localized reducing conditions. The concentrations of the attenuation parameters fluctuated significantly over time, suggesting the reducing conditions indicated by these results are limited in extent. The presence of an overall aerobic environment is suggested by the return to relatively high dissolved oxygen, relatively~~

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~~low dissolved iron, and relatively high nitrate concentrations at downgradient locations.~~

Page 49, Section 8.2.2 is revised as follows, starting with the second paragraph of the section:

Groundwater discharge from the I Sand Unit to the ravine in Spring Lake Park may present a potential pathway for exposure if groundwater COPCs are present. However, groundwater COPCs were not detected in samples collected from the I Sand Unit in the three temporary piezometers located upgradient of the ravine. Therefore, there is no exposure to groundwater COPCs at Spring Lake Park. The reduction in concentration of COCs between the source area and MW7I suggests significant physical and/or chemical attenuation of the plume. Groundwater geochemical conditions in and downgradient of the source area indicate reductive dechlorination is an important attenuating process at the Facility. COPCs will naturally attenuate along the groundwater flowpath. The Spring Lake park area is relatively distant from the Facility, approximately one mile to the east. At a groundwater velocity of 200 feet per year, it would take a particle of groundwater approximately 25 years to travel from the Facility to the Spring Lake Park area. This will allow ample time for natural processes to attenuate COPCs. Continued attenuation of COCs along the groundwater flow path at rates observed at the Facility will result in attenuation of the plume before it migrates 5,000 feet. This is based on simple assumptions of groundwater flow conditions and first order decay of COCs.

Page 53, the last paragraph of Section 9.2.2, is revised as follows:

Groundwater discharge from the I Sand Unit to the ravine in Spring Lake Park may present a potential pathway for exposure, to the extent groundwater COCs were present. However, groundwater COCs were not detected in samples collected from the I Sand Unit in the three temporary piezometers located upgradient of the ravine. Therefore, there is no exposure to groundwater COCs at Spring Lake Park. It is likely that COCs have attenuated between the Facility and Spring Lake Park, given that Spring Lake Park is nearly one mile from the Facility. TCE concentrations declined more than 90 percent over just 700 feet from MW4S to MW7I, and natural processes of sorption, diffusion, dispersion, and chemical degradation will continue to attenuate COPCs along the groundwater flow path. ~~At a groundwater velocity of 200 feet per~~

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year, it would take a particle of groundwater approximately 25 years to travel to the Spring Lake Park area, allowing ample time for attenuation of COPCs. Therefore, the risk of future COC migration to Spring Lake Park is very low. Based on the strong evidence of chemical degradation at the site and continued degradation in the downgradient direction, the front of the plume of TCE would be expected to degrade to non-detectable concentrations before reaching the Spring Lake Park area.

Page 57, Section 10.0, will be revised to include the following references:

Pankow, J.F., and J.A. Cherry, 1996. Dense Chlorinated Solvents and other DNAPLs in Groundwater. Waterloo Press.

U.S.EPA, 1998b. Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater. Office of Research and Development, EPA/600/R-98/128, September 1998.

Wiedemeier, T.H., H.S. Rifai, C.J. Newell, and J.W. Wilson, 1999. Natural Attenuation of Fuels and Chlorinated Solvents. John Wiley & Sons, New York.

Xu, M. and Y. Eckstein, 1995. Use of Weighted Least-Squares Method in Evaluation of the Relationship Between Dispersivity and Scale, Journal of Groundwater, 33(6): 905-908.

21. The term COC will be used instead of COPC on Page 49, throughout Section 8.2.2.
22. This comment is addressed with Comment 20.
23. Page 53, Section 9.3.1, will be revised as follows:

9.3.1 Soil

Chemical concentrations that are considered representative of the average concentration to which an individual might be exposed over an extended period were estimated using soil analytical data. Areas of the Facility that contribute most significantly to the overall risk were identified by comparing the representative concentration for each of the COCs to criteria prescribed by U.S. EPA for an adult industrial worker. The criteria are also protective of a construction/utility worker. The

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areas of soil that require corrective action to reduce risk to acceptable levels are located west of the road that bisects the Facility, and generally in the southwestern part of the Facility. Aggregate ~~Target~~-target risk levels of 1×10^{-5} (risks for individual constituents did not exceed 3×10^{-6}) and hazard index of 1 were used for carcinogenic and noncarcinogenic chemicals, respectively. Pesticides, particularly aldrin and dieldrin, are present at concentrations that may pose an unacceptable health risk to people working in this area, should the existing Permalon liner be removed at some point in the future and the workers incidentally ingest, come into contact with, or inhale dust. If this area is addressed by corrective action, the residual risk will at a level that generally would be considered to be acceptable.

24. Footnote 2 on Table 5 is used on Page 2 for PZ1, PZ2, and PZ3. To clarify, the footnote will be revised as follows:

Northing and Easting coordinates for PZ1, PZ2, and PZ3 were measured from a separate coordinate system.

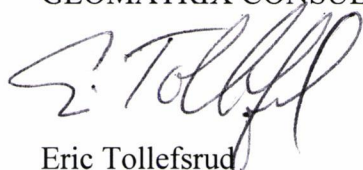
25. The blank cell in the list of analytes on Table 21 (now Table 24) will be deleted in the final report.
26. Figure 5 has been revised to include an inset illustrating the location of the cross section.
27. Figure 6 has been revised to include a note stating that the alignment of the cross section is illustrated on Figure 7.
28. Figure 13 has been revised to illustrate trichloroethene concentrations in soil at Soil Boring SS8. Soil samples at monitoring well MW6I were not tested for trichloroethene.
29. A legend will be added to Figure 20 to explain that the shaded area represents the area of the site that would need to be addressed by corrective action to reduce the residual risk to acceptable levels. Soil sampling locations where results indicate the area needs to be addressed will be highlighted. This area accounts for all the COCs within this area such that the residual risk associated with exposure to the COCs remaining outside the area is equal to or below the target risk levels for carcinogenic and noncarcinogenic effects.

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In addition to the revisions noted above, Table 21 (now 24), "Constituents of Concern in Soil" will be revised to match Table 1 in the draft CMS Work Plan, which includes constituents of concern in both soil and groundwater. The title of the table will be revised accordingly.

If you have any questions, please do not hesitate to contact Jim Hooper at VW&R, 630-761-0486 or Eric Tollefsrud at 612-544-4614.

Sincerely yours,
GEOMATRIX CONSULTANTS, INC.



Eric Tollefsrud
Senior Hydrogeologist



Gary Hokkanen
Vice President/Principal Hydrogeologist

ET:ke

Attachment

cc: Mr. Jim Hooper, Van Waters & Rogers Inc.

TABLE 14

COC FATE AND TRANSPORT PARAMETER VALUES

Buckingham Place Facility
Omaha, Nebraska

Parameter	Value	Basis
Horizontal groundwater velocity	200 feet per year	Site data
Longitudinal dispersivity (alpha x)	50 feet	Xu and Eckstein (1995)
Transverse dispersivity (alpha y)	5 feet	10% of alpha x
Vertical dispersivity (alpha z)	0 feet	Set to 0 as conservative factor
Hydraulic conductivity (K)	0.034 cm/sec	Site data
Hydraulic gradient (i)	0.002	Site data
Effective porosity (n)	0.35	Site data
Partition coefficient (K _{oc})	126 l/kg	Pankow and Cherry, 1996
Organic carbon (f _{oc})	0.00048	Site data
Bulk density	2.6 kg/l	Site data

The horizontal groundwater velocity was calculated using Darcy's Law as given below:

$$v_{gw} = \frac{Ki}{n}$$

where K is the horizontal hydraulic conductivity, i is the horizontal hydraulic gradient, and n is the effective porosity of the porous medium.

The retardation of constituent migration in groundwater via adsorption is directly proportional to the amount of naturally occurring organic carbon in the porous media. The retardation factor was calculated using the formula given below:

$$R_f = v_{gw}/v_c = 1 + K_p(\rho_b)/n$$

where v_{gw} is the horizontal groundwater velocity, v_c is the velocity of the constituent of interest, K_p is the partitioning coefficient, ρ_b is the bulk density of the porous material, and n is the effective porosity.

The equation used to estimate the partitioning coefficient is as follows:

$$K_p = K_{oc}f_{oc}$$

where K_{oc} is the partition coefficient of the constituent on organic carbon, and f_{oc} is the fraction of organic carbon in the soil.

TABLE 19



SUMMARY OF DETECTED METALS CONCENTRATIONS

4120 Buckingham Place
Omaha, Nebraska

Concentrations are reported in milligrams per kilogram (mg/kg)

Metal	Detected Concentrations			Adjacent Facility Mean ¹	Native Soils ²	
	Minium	Maxium	Mean		Mean	Range
Aluminum	3,690.0	17,000	10,963	9,853	33,000	7,000 - >100,000
Antimony	-- Not detected --			Not detected	0.52	< 1 - 8.8
Arsenic	3.3	13	5.8	5.7	4.8	< 0.1 - 73
Barium	13.0	339	156	187	290	10 - 1,500
Beryllium	0.26	2.7	0.82	0.72	0.55	< 1 - 7
Cadmium	2	2	2 ³	Not analyzed	None reported	None reported
Calcium	2,360	11,700	4,138	Not analyzed	3,400	100 - 280,000
Chromium	6.00	32.0	13.5	11.9	33	1 - 1,000
Cobalt	3.5	16	8.6	7.9	5.9	< 0.3 - 70
Copper	11	76	18	16	13	< 1 - 700
Iron	646.00	59,900	14,200	12,275	14,000	100 - >100,000
Lead	1.30	829	16.8	19.6	14	< 10 - 300
Magnesium	549.0	8,510	3,602	Not analyzed	2,100	50 - 50,000
Manganese	33.0	1,470	415	413	260	< 2 - 7,000
Mercury	0.047	0.24	0.11 ³	0.047	0.081	0.01 - 3.4
Nickel	4.30	32.0	17.9	19.7	11	< 5 - 700
Potassium ⁴	1,260	2,400	1,729	Not analyzed	12,000	50 - 37,000
Selenium	0.75	1.2	0.94	0.75	0.30	< 0.1 - 3.9
Sodium	68.0	1,160	344	Not analyzed	2,500	< 500 - 50,000
Thallium	-- Not detected --			Not detected	7.7	2.2 - 23
Vanadium	16.8	49.0	26.6	24.1	43	< 7 - 300
Zinc	33.0	430	57.8	74.2	40	< 5 - 2,900

Means are geometric in accordance with Shacklette and Boerngen, 1984.

¹ Source: Geomatrix, 1998.

² Source: Shacklette and Boerngen, 1984; concentrations from eastern United States (east of 96th meridian)

³ There were three detections for cadmium, two for mercury.

⁴ The mean for native soils is arithmetic for potassium (Shacklette and Boerngen, 1984).

TABLE 21

NATURAL ATTENUATION SCREENING PROTOCOL

Buckingham Place Facility
Omaha, Nebraska

Parameter	Source Area Conditions	Interpretation
Oxygen	<0.5 mg/L	Anaerobic conditions necessary for dechlorination
Methane ¹	>0.5 mg/L	Reductive daughter product
Iron II	>1mg/L	Reductive pathway possible
pH	5<pH<9	Optimal range for reductive pathway
Sulfate	>20 mg/L	May compete with reductive pathway
Nitrate	>1mg/L	May compete with reductive pathway
TOC	<20 mg/L	Potential limiting factor
Oxidation reduction potential	Rel. low to background	Anaerobic conditions in the source area
Chloride	>2x background	Daughter product of organic chlorine
DCE	Rel. Abundant	Daughter product of TCE under reducing conditions
DCA	Rel. Abundant	Daughter product of TCA under reducing conditions
Ethene/ethane	>0.1 mg/L	Daughter product of vinyl chloride
Chloroform	Rel. Abundant	Daughter product of carbon tetrachloride under reducing conditions
Dichloromethane	Rel. Abundant	Daughter product of carbon tetrachloride under reducing conditions

1. Downgradient methane concentration is <0.5 mg/L, supportive of oxidation of vinyl chloride.
mg/L - milligrams per liter